Memorandum

To : John Sanders, Ag. Program Supervisor
Environ. Hazards Assessment Program

Date : July 9, 1990

Place : Sacramento

From : Department of Food and Agriculture — Kean Goh, Sr. Environ. Research Scientist
Environmental Hazards Assessment Program

Subject : Summary of the Environmental Fate of Malathion

The following summarizes information to date on the transport and fate of malathion in the environment.

AIR

Photolysis is not an important pathway in the environmental fate of malathion. Chukwudebe et al. (1989) reported that (1) at the end of 25-h of sunlight irradiation, there was no measurable decrease of the initial applied malathion in the coated Petri dishes; (2) at the end of 72-h irradiation with a UV light source, 84% of the deposited malathion still remained on the Petri dishes. Breakdown products include O,O,S-trimethyl phosphorothioate, trimethyl phosphate, and O,O,S-trimethyl phosphorodithioate.

Urban Area Monitoring Data

Malathion levels never exceeded 1 ug/cu.m, and the malaoxon concentrations never exceeded 0.1 ug/cu.m during a six weekly aerial application of malathion bait (2.4 fl oz of 91% malathion). (Oshima et al. 1982).

WATER

Laboratory Studies

Half-life ranging from 1-10 days depending on pH of the water.
Mulla (1963). Two ppm of malathion in tap water (pH 8, 95°F, constant fluorescent light 64 foot-candles) degraded rapidly: half-life ca. 1d; 60% remained after 24 h, <14% after 48 h, and none remained after 72 h.

Cowart et al. (1971). One ppm of malathion in distilled water (pH 6): half-life ca. 7d; 9% remained after 28d, and none remained after 35d.

Eichelberger & Lichtenberg (1971). Ten ppb in river water (pH 7.3-8.0): half-life 4.3d, none remained after 28d.

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Bourquin (1977). One ppm of malathion in sterile seawater (pH 7.2): half-life 4.1-10.2d, malathion degradation increased with salinity; half-lives were 2d in nonsterile marsh water and 61d for sterile distilled water.

Field Studies

Half-life <24 h.
Guerrant et al. (1970). Malathion was aerially applied (ULV) at 3 fl oz per acre over ponds, streams, water tanks, troughs, or holding ponds (pH 6.8-9.5). Maximum concentration found in waters was 0.5 ppm which decomposed with a half-life of 0.5 to 10 days, depending on pH. Water samples taken after the fourth application showed concentrations of malathion at 104, 5, 1.4 ppb at 4, 24, and 48h post spray, respectively.

SOIL

Laboratory Studies

Half-life ranging from <1-3 days.
Walker & Stojanovic (1973) attributed 5-23% of the total malathion degradation to abiotic factors and 77-95% to microbiological factors, depending on the soil types. Three soil types were used: a sandy loam (pH 5.3, OM 1.1%); a clay soil (pH 7.4, OM 3.1%); and a loam (pH 7.2, OM 4.7%). Soils were fortified at 16 ppm malathion incubated at 25 C for 10 d. In non-sterilized soil (microbial degradation) after 1 d, 8% malathion remained in the loam, 13% in the clay, and 70% in the sandy loam. After 3 d none remained in the loam or clay soil while 48% remained in the sandy loam. At the end of 10 d only 1% remained for the sandy loam soil. In sterilized soils (chemical degradation) after 10 d, 95% malathion remained in sandy loam, 90% in loam, and 77% in clay.

Getzin & Rosefield (1968) reported that 1% of malathion remained after 7d in silt loam and 3% remained after 1d in clay loam soils.

Konrad et al. (1969) (in US-EPA) found that 50-90% of the initial quantity of malathion was degraded in 24 h, depending on soil types, in both sterile and nonsterile systems.

Field Study

Half-life <3 days.
Lichtenstein & Schulz (1964) applied 5 lb ai/a to silt loam soil. Only 15% of applied malathion was found after 3 d and 5% after 7 d.

PLANT SURFACES

Tagatz et al. (1974) applied malathion to salt marsh ecosystem as a thermal fog with 95% malathion mixed with diesel fuel oil at 6 oz ai/a, and three applications were made. Highest level of malathion 4.1 ppm on Juncus marsh grass was detected, and at 7 & 14 d after each application <0.05 to 0.1 ppm were detected. After 3 ULV sprays (0.64 fl oz/a) 0.41 and 0.28 ppm of malathion were detected on Juncus at 1 and 3 d.

OXIDATION

Hydrolysis, not oxidation, is the predominant pathway of environmental degradation of malathion (EPA 1975).

Photo-oxidation - The conversion of malathion to malaoxon through the action of sunlight is minimal. Only trace amount of malaoxon (<0.00005% of initial malathion) was detected in a Petri-dish test (Chukwudebe et al. 1989).

Chemical oxidation - Malathion could be converted to malaoxon in natural waters mediated by dissolved oxygen in water, or by oxidizing agents such as chlorine and potassium permanganate used in sewage treatment plants (Gomaa & Faust 1970). Malaoxon, however, is quickly degradable in aquatic media.

Biological oxidation - The activation of malathion to malaoxon is mediated mainly by mixed function oxidase enzyme in animals and other oxidases in plants. The action of microorganisms in soil on malathion is predominantly degradation rather than activation. No evidence is available to support whether or not the conversion of malathion to malaoxon occurred by microbial action. The oxon products if formed are less stable and easily degradable to nontoxic metabolites, probably due to their increased solubility and electrophilic nature, making them more susceptible to hydrolysis than the parent compound.

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